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CHANGES IN THE YELLOWSTONE PARK.

BY

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Numerous items have come to my attention referring to the changes in the Yellowstone Park.

The claim is made that there is a decline in the forces that constitute the Park what it is, and that this looks toward the dying of the geysers. Some even urge us to see the Park quickly, for fear these wonders cease. I surely urge all to see the Park and live, rather than "Naples and die." This is not because the Park is dying, but because men may die before they see it.

Before railroads reached the Park it was my good fortune to visit the region by coach and saddle. I then became intensely interested in all the strange features that mark this as the most remarkable place on earth. I then examined many of the wonders that lie outside of the strict limits of the reserve. Since then I have often visited the Park in its entire circuit, each time with deeper interest; and have also by special request done some classifying of the geysers.

I venture some description of actual changes taking place and of their possible bearing on the future of the Park.

ENDLESS BOILING-POINTS.—Over the entire area there are endless small boiling-points, or fumaroles, extending for at least one hundred miles from a given centre. These sputter and bubble away with slight change of opening from year to year. Some trifling external cause may vary these a little, while occasionally one seems to dry up and go out of action. But even this apparent loss is often but the result of a dry coating of mud, forming too heavy a crust for the slight force to penetrate; and it is not uncommon to hear the baby geyser with smothered voice still chirping beneath the surface. Indeed, the most striking impression made is that of uniformity as to a given action.

In the natural construction department, as where the thermal springs are constructing terraces, it is plain to be seen that there must come points at which that process ceases—ceases for the simple reason that the work at that point is finished, when the processes turn to duplicate the formation in a new direction. This is evident all about the region, as seemingly a large portion of these elevations has been so constructed. This is doubtless true of the Bad Lands of Dakota and Wyoming. All of this speaks not of visibly dying energy, but of the limits of that energy and of its uniform support up to the point of that limit. It is changes of this sort that have led to the outcry as to the dying Park.

ILLUSTRATIONS.—In 1888 Minerva Terrace was very beautiful and rich in colour, as it was then very active, and the hot-water flow abundant. A year later the charming colour was all gone from this lovely terrace. We then mourned the apparent death of this goddess. A careful survey of the field showed that while here was a striking change, it was not of energy. Instead of the loss of energy, the current had been diverted in another direction and was now evidently giving its flow to Cleopatra Pool, a little to the north, whose terraces in turn were being freshly coloured; for this north terrace had never been seen so richly active or beautiful by this writer at any other time. To our great delight, the next season the pools of the Minerva were again overflowing the brim; the current, however, was not sufficient to give colour to the entire terrace, but only to the quarter toward the pulpit. But the colour was spreading with returning increase of the water-flow, while the north pool was consequently losing its water and beauty.

THE RICH COLOURINGS.—It must be remembered that all these rich colourings depend on the continual flow of this scalding water. When the water ceases, then decrepitude begins immediately, and colour fades directly.

The colours are produced by the acids, realgar, orpiments and various oxides, as well as by the possible fungous growth in the waters.

HOW IT IS DONE.—Another place to observe is that of the most delicate Angel Terrace. Between my visits of 1899 and 1900, this bewitching terrace-well became entirely dry and the colours were all gone, leaving a deathly white mass of crackling calcium, that looked like slaking lime. I pushed on through the bushes, only to find that the current's flow had been altered, and that an entirely new terrace was now being formed a hundred feet below. Really a new Angel, and you may expect its colouring to be similar to the older terrace, for the same chemical processes are creating it. It was also observable that this new terrace had formed with great rapidity. This was caused by the fresh breaking up of the lower incrustations and the running of the hot stream in these new and fresh channels. This newly fractured surface, yielding more rapidly to the intensely thermal water, was thus supplying material for building more rapidly. These water currents running a long time over the same old surfaces gradually exhaust the calcium deposits, and they also form slight silicic surfaces on their throats that yield little new material. Hence, they build more and more slowly above, until some new fractures below give fresh material to the terrace-building water.

This is plain when we remember that these very hot waters dissolve the calcareous rocks below, and, being forced upward to a vent, bearing calcium carbonate in solution, when it reaches the surface air the already loaded water now absorbs carbon-dioxide, and so becomes overloaded and liberates the calcium to be again deposited in the formation of the beautiful upper terraces.

AT MAMMOTH HOT SPRINGS.—These two cases are characteristic of other external changes manifest at Mammoth Hot Springs, but there has been no slackening of energy here for twenty-seven known years. There are no geysers at this point, they being found twenty miles further up the Park. Here at the Mammoth Hot Springs are chiefly vents of hot water, and hot air, and large scalding pools of azure-blue water in charming terraced basins of calcium.

THE GREAT GEYSERS.—Reference is often made to the supposed extinct Excelsior Geyser as evidence of this dying force. I venture to suggest that its later eruptions have rather been so very excessive that its throat has become seriously enlarged, until an equal force, that once would have thrown a smaller stream to an enormous height, is not sufficient to carry the enlarged weight; at least, not so often.

On February 21, 1891, this enormous geyser was reported as playing again, after eleven-years' silence, and it was said also that a new geyser had broken out near the small fountain. But, on thorough investigation I found the report overdrawn and misleading, having been sent out by some winter wanderer for excitement.

The Excelsior eruptions have been very extensive, for its great volume of hot water was always sufficient to melt the ice and kill the fish for over two miles in Fire Hole River.

As an illustration of a geyser, you are to think of a rubber hose, the size of whose nozzle determines the distance to which it will throw a stream; while with a clearly defined nozzle removed the stream will only fall lifelessly from the open end of the rubber pipe. So it may prove later that some of the apparently dead geysers are not dead, or quiet, because of lesser force, but because of less clearly defined throats, thus demanding *greater* force, which they do not possess. As a matter of fact, some of these geysers do in time actually mend their throats or pipes and then begin again to play. The Grand Geyser is a case of this kind, as, after a long rest, it was doing business again at the old stand in 1891, as Mr. Howe, the observant keeper at the upper basin, told me, though I just missed seeing it play.

Doubtless, many of the hot pools are former geysers whose currents are now temporarily directed to other openings. These new openings may be so large even as to produce only quiet flowing streams, entirely unobserved; or they may be directed in internal currents mingling far below, to rise again, or not. These pools may, any of them, begin playing at any time, for we have seen that they are not silent because of lesser energy, but of energy directed into other channels. Some of these mend their broken pipes more quickly than others, from various causes, like that of the presence of more or less free silica in the water.

THE CHANGING GEYSERS.—The Fountain Geyser broke our hearts by becoming irregular in 1899. Another geyser burst out not a hundred feet away and ran a very brilliant but irregular career for a short season. But the sum total of its force was so nearly equal to that of the old Fountain in a given time, that it was easy to determine their relation, there not being sufficient force or water to run two simultaneously. The new geyser threw its triple streams farther than the old, but with smaller proportions, because its three exits were smaller. There is no doubt that a break had taken place below in the pipe of the old geyser, and the current was firing from a smaller nozzle, and hence more brilliant.

Some hastened to write for the press that the Fountain Geyser was dead and the Park would soon be extinct. Other interested parties printed it abroad that a new and glorious geyser had broken out, and wanted to give it some political name, which I think would have been fitting, because of its fickleness. Neither party was correct, as it was the same thermal force, and in 1900 I saw Fountain Geyser playing again with its old regularity and undiminished glory, as Nature's plumbers had mended her broken pipes.

A STRIKING CASE.—The Black Growler is another striking case. This is a half cone three feet in diameter, four feet high. Through this cone an enormous amount of apparently superheated steam rushes continuously with such tremendous force as to produce a roaring gong that can be heard two miles. All at once a series of very small vents broke out of the crust in front of it, and soon the single growler became silent. In its place some thirty little whistlers kept up their noise. But the sum total of the many was equal to the larger one now ceased. Moreover, there had been developing another growler some hundred feet northward. I do not believe the new one has anything to do with the old one; rather it is an independent steam geyser reversing the experience of the Old Growler, in that a group of whistlers have gracefully built a strong united silicated throat, and so broken up the partition between themselves, forming thus a vast combine. The many whistlers are thus making now one huge "trust," which by and by becomes so vast it breaks to pieces by its own force, and returns again to the many. I presume these two steam geysers are thus playing back and forth between one large opening and many small ones.

I had a fine chance that season to study the cone of the Old Growler, as but little steam was then emitted. It has a fine sounding-board of silicious sinter, and prettily lined with a species of white porcelain of various tints. This Old Growler is now receiving its former strength from the many little whistlers that will later give their steam again to the large opening. They in time will be filled over with sinter or geyserite.

These few illustrations suffice to demonstrate that each geyser and fumarole on this vast solfatara has its individual silicified tube to its own origin. For a common origin would give a common level at the surface.

It must also show that these later forces of volcanic periods are not materially changing in energy, and that centuries may pass before any real force may exhaust itself; perhaps never, and this may be earth's perpetual vent. It is at least God's workshop, where He is doing the last work in forming the earth's crust by the marriage of the gases.

Let me, in conclusion, relate one remarkable convulsion that may be illustrative of how a redoubled force becomes sometimes evident, or how a hindered force sometimes asserts itself.

A HIDEOUS HOLE.—The mud volcano is a very hideous revelation of the Park. It is a funnel-shaped sink about 40 feet deep and 40 feet across the top. A tunnel runs southward whose upper arch is about 10 feet from the bottom of the dismal pit. Up against the top of this tunnel every second is hurled some three cartloads of odoriferous, soft, slimy, black mud. This then shoots out to the opposite side of the funnel, falling back only to be hurled up and out again forever.

This churning goes on, gradually growing thicker with accumulated mud, until the vent becomes choked, as it did a few years ago. Then there came a fearful explosion, when the huge monster threw up and out the whole mass, and threw it, as I judge, for 150 feet, plastering thus the stumps and trees with the black vomit. This awful mud was so sticky that it adhered to the trees from top to bottom for, surely, several months, and they looked sick indeed. It was really a hideous sight.

I met some one who told me the Mud Geyser was much "changed." He evidently had simply observed that it was now playing with muddy water not so dense as before; but he had failed to observe the mud on the trees and the surrounding earth, which would have led him to note that its force was not only well sustained but for once seemingly overdone. Indeed, it was no evidence of change, but a part of the programme, as the clock ticks every second, striking at given periods of an hour, and the strike does not betoken change, but regularity of longer intervals, some seconds, some hours. So ever go on these changes in the Park, that are no changes at all, but periods that are marked by wonderful regularity, endless variety.

No man can say that he has visited earth's greatest wonder until he has made at least one complete tour of the Yellowstone National Park. It can be made with perfect ease, and for a very modest expense. It is the nearest to Nature's heart you can possibly get.

GEOGRAPHICAL RECORD.

AFRICA.

Lake Chad.—In a recent address, entitled *From the Niger to the Nile* (Scot. Geogr. Mag., Jan., 1908), Lieut. Boyd-Alexander noted the supposed decrease in the area of Lake Chad. It is his opinion that the lake does not alter much in size, and that the supposed greater original area is due partly to inaccurate surveying and partly to the fact that certain villages are several miles distant from the lake, giving the impression that they were formerly on the shore line. The position of these villages Lieut. Boyd-Alexander believes to be due to the danger of flooding during the blowing of the Harmattan, which causes the water to flow 600 yards over the land with an ordinary wind, and drives it as far as two miles when the wind is strong. Where there are good banks, and where the water is not influenced by the prevailing winds, there are many villages close to the lake. A chain of islands, once separate and now more or less joined by a marsh, has also given the impression of increasing aridity, but this change may